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Reverse Engineering Legacy Data Storage Drives

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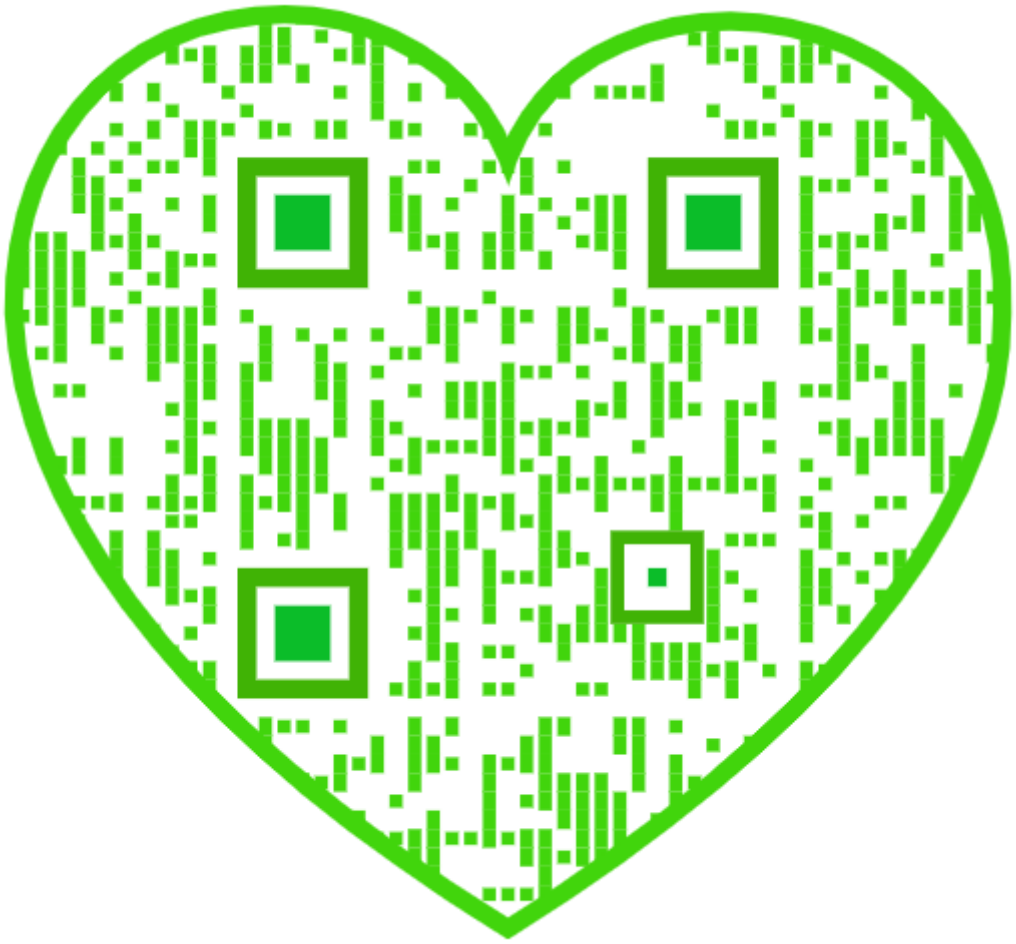

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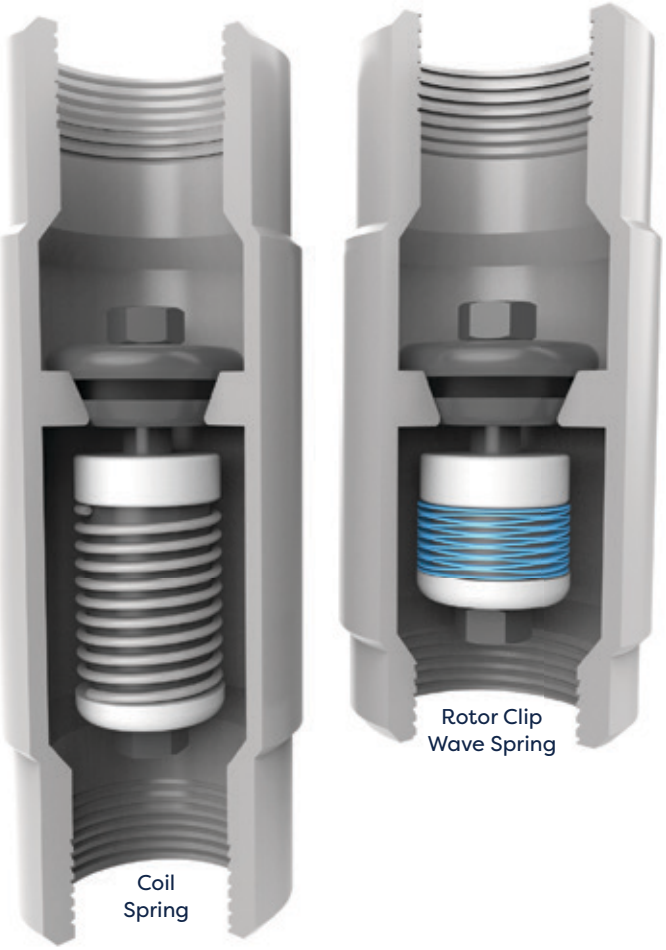

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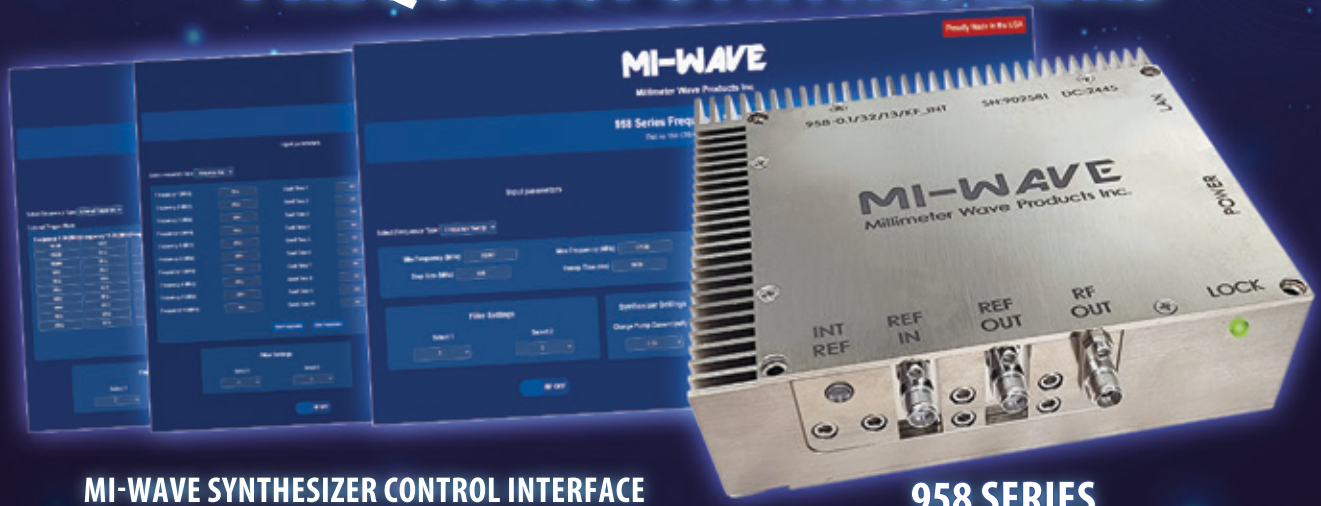

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Contents

FEATURES

Avionics

4 The Art of Reverse Engineering Yesteryear for Aerospace and Defense Data Storage Drives

Manufacturing

9 Manufacturing Spotlight: Machining Complex Parts and Materials for Space Flight and Exploration

Hypersonic Testing

16 Notre Dame's New Boundary Breaking Mach 10 Quiet Wind Tunnel

RF & Microwave Technology

21 Shape Shifting Antenna Poised to Transform Communications

24 British Army Completes First Test of Drone Killing Radio Frequency Weapon

TECH BRIEFS

25 A Swarm of Sensors, Rovers and Astronauts Explore the 'Moon'

26 Army Researchers Examine Nanotechnology for Climate Solutions

28 Airman Brings Fuel Sampling Innovation to Eglin, Possibly Air Force

30 Atomic Fountain for Research in Quantum Sensing Nears Completion of First Phase

33 Revolutionizing the Waves: A Breakthrough in Surf Observation Technology for Sailors and Marines

DEPARTMENTS

35 Application Briefs

38 New Products

40 Ad Index

ON THE COVER

The first article in our new "Manufacturing Spotlight" section covers the use of CNC machines for manufacturing complex materials, parts and components for space flight and exploration. To learn more, read the feature article on page 9.

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The Art of Reverse Engineering Yesteryear for Aerospace and Defense Data Storage Drives

As their decades-old electromechanical drives start to fail the continued performance of many computer-based systems is put at risk. Form-fit-function replacements made using solid-state technology can save the day, but making them is not without challenges.

Within the aerospace and defense industry there are many computer-based systems in regular use that were designed and built decades ago. These legacy systems are heavily relied upon and include equipment installed on aircraft and in land vehicles as well as a wealth of ground-based equipment such as training simulators and stations used for configuring/testing line replaceable units (LRUs).

These systems, some of which were designed in the 1970s, include data storage technology once considered state-of-the-art; technology such as early generation SCSI, IDE (PATA) hard disk and tape drives, ESDI, Shugart, and IDC floppy disk drives. With their moving parts, these decades-old drives are failing.

Understandably, the drives (figure 1 shows an example) that were designed into these systems are long obsolete. However, recognizing that the electromechanical drives were a potential weakness in the host's overall reliability, some end users and support companies did have the foresight to order spares while they were still available. When retrieved from their long storage though, these spares fail more often than not. In the case of hard disk drives (HDDs), many models have heads that rest on the surface of the disks when they are not spinning. Over time the heads can stick, preventing the disks from spinning or they are ripped from their suspension mechanisms if the disks do spin.

Finding a replacement drive that works, even a reconditioned unit, is very difficult because in most cases it must be the exact same model; and even then, success is not guaranteed. This is because of how many OEMs (of the drives and the host systems) collaborated to ensure exclusive compatibility. For instance, SCSI was an extremely popular means of connecting computer

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peripherals in the 1980s and through to the early 2000s. It was standardized in 1986 as the SCSI parallel interface (SPI), 8-bit wide, single-ended bus. However, OEMs did not always implement the full standard, retaining just the SCSI command protocol or the SCSI architectural model, for example.

Accordingly, in the '70s, '80s, and '90s many SCSI drives were designed with a specific host in mind, and the OEMs often agreed that their respective products would behave in a mutually exclusive manner, under particular circumstances. For example, they would often agree on a unique mode page setting, or mode page in the memory map and/or exclusive handshaking protocols when data passes between host and drive.

Such pairing means a donor drive would need to come from an identical host. But even then, the replacement may not work. This is because the OEMs might have also agreed that the host be capable of detecting when a new drive has been installed. The means of detection might include looking for pre-arranged data to mark its authenticity. By the same token, the host may expect to see any replacement drive prepopulated with data from the old drive, and the drive manufacturer would have offered a data duplication service in the day.

Figure 1. A hard disk drive from the mid-1990s. (Image: Solid State Disks Limited)

Figure 2. NATO is replacing the electromechanical removable media assemblies of its AWACS aircraft with solid-state-based units that improve reliability and provide additional features. (Image: Solid State Disks Limited)

All of the above issues make finding a replacement for the original drive virtually impossible. Moreover, modifying the host to accept a different drive is impractical because it would cost a great deal, and the host would probably need to be offline for a long time. More importantly, modification will be prohibited in most cases because the host's functional behavior will have been certified.

With the host expected to provide several more years of service, the only practical solution is to replace the failing electromechanical drive (ideally before it fails) with one that emulates the exact behavior of the original. This is rather specialist work and only a few companies offer reverse engineering services for obsolete computer drives. For those that do, their starting point is to hunt down the details of the drive's mechanical and electrical interfaces. Finding some generic information online is usually possible, but finding details of anything the host and drive OEMs might have agreed upon to ensure exclusive pairing is much harder, seeing as one or even both companies may no longer be in business.

In the absence of sufficient information an original drive will need to be interrogated. The best scenario here is that the end user or whoever is responsible for maintenance may have a drive that is faulty (worn mechanical parts) but which still performs its communications handshaking. Worst case, analysis equipment such as a logic analyzer must be taken to the host and placed between it and the drive so that signal timings and communication protocols can be captured. Great care needs to be taken when handling the original drive though as it could be more than 30 years old and will be very fragile.

Once it is understood exactly how the host and drive communicate, that behavior can be replicated using modern technology such as low-power microcontrollers, field programmable gate arrays (FPGAs) and solid-state memory. For instance, most legacy drives are based on logical blocks, where the exact encoding of the data onto the

disk is handled internally by the storage device. For some classes of device, such as ESDI or floppy, the encoding must be implemented in the new storage device's firmware. This is a complex operation that can only be achieved by reverse engineering the particular implementation, including a detailed low-level examination of the format written to the media, which sometimes varies across the surface.

As mentioned, the host might be expecting to see certain data present to indicate a new drive has been fitted, or it might expect to see the same data as before. The first scenario is a simple formatting exercise. Data duplication though requires access to the drive in the host. Again, great care must be taken.

A solid-state replacement can be created for virtually any SCSI-based drive that was in use in the 1980s to early 2000s, irrespective of how the OEMs of the host and drive might have collabo-

A NATO E-3A Airborne Warning and Control System (AWACS) aircraft sits on the tarmac at Siauliai Air Base in Lithuania. NATO is in the process of replacing the removable media assemblies in its AWACS aircraft fleet that use Seagate HDDs that are more than 20 years old. (Image: NATO)

rated to pair their products. By giving the new drive the same physical connector, interface protocol, memory maps, formatting (including pre-loaded data, if applicable) as the original drive, the host does not need to be modified. It will not be aware that it is writing to and reading from latest technology, high-speed, solid-state memory as opposed to a magnetic disk or tape. Indeed, the replacement drive's software often needs to include delays to slow down data retrieval. For instance, a tape drive might need to rewind the tape. Solid-state technology can provide the data almost instantly, but the host's software might not be ready for it.

As for the storage media, industrial grade Compact Flash (CF) and CFast cards are used in most cases. If the new drive is to replace a hard disk drive, the CF card can be hidden behind a plate so that it cannot be removed. Alternatively, it can be ejectable if the original drive had used removable media such as a floppy or optical disk or magnetic tape.

Understandably, reliability is greatly improved as there are no moving parts in the replacement drive. It draws less power than the original electromechanical drive and is quieter too. Also, some end users decide to take advantage of the opportunity to add functionality that the original drive never had.

For example, the NATO Airborne Early Warning & Control Force (NAEW&CF), based in Geilenkirchen, Germany, is currently in the throes of replacing AWACS aircraft removable media assemblies (RMAs) that use Seagate HDDs that are more than 20 years old.

The replacements (see figure 2) replicate the exact behavior of the original HDDs, so the AWACS aircraft require no modifications. However, NAEW&CF's new drives have the ability to eject the memory cards, whereas before the original HDD-based units had to be removed in their entirety, risking damage to the connectors on the rear. The replacement drives also have an Emergency Erase button on the front panel. This can be used to quickly destroy all data on the memory card if the crew feel there is a risk of the aircraft falling into enemy hands.

In summary, the failure of electromechanical drives has been placing, and continues to place, the reliability of many computer-based systems in use in the aerospace and defense industries at risk. Finding original replacements is virtually impossible and in most cases the host cannot be modified to accept a modern COTS drive. The only recourse is to use a solid-state-based drive that replicates the exact same behavior as the original drive.

This article was written by Brian McSloy, Chief Technology Officer, Solid State Disks Limited (Reading, UK). **For more information, visit www.solidstatedisks.com.**

Manufacturing Spotlight: *Machining Complex Parts and Materials for Space Flight and Exploration*

This is the first article in a new section of *Aerospace & Defense Technology* called "Manufacturing Spotlight," where we will cover some of the latest machines, tools and other technologies being used by aerospace and defense industry design and manufacturing engineers. The first topic in this new section is "Machines," and specifically the computer numerical control (CNC) machines being operated by a company that has been expanding its custom manufacturing services for the aerospace and defense industry in recent years, JR Machine.

Who is JR Machine?

JR Machine is a Shawano, Wisconsin-based contract manufacturing company that is leveraging advancements in CNC Machines to keep pace with the growing complexity of parts designed to operate in space.

The company was first established in 1992 and has expanded from its initial focus on bushings and pins to today where they're machining parts that are featured on some of the most recognizable names in the space industry. Their facility in Shawano has more than 30 total DMG Mori CNC turning and machining centers. Their capabilities include CNC machining of nickel-based superalloys, prototyping, engineering, multi-spindle machining, thread rolling, fabrication, and assembly, among other manufacturing services.

In an April 2024 blog article posted to its website, JR Machine describes how they have expanded their Shawano facility with the addition of a new engineering center and tooling storage room. The new engineering center is now separate from their quality lab, which was previously combined into one space. The engineering center is where all of their manufacturing jobs are programmed and designed for manufacturing assessments. It hosts two workstations with a view of most of the DMG Mori machines in their facility and also provides a meeting space with customers to discuss the unique aspects of each contracted job.

JR Machine has a nearly 40,000 square foot facility in Shawano, WI where it specializes in machining complex parts from nickel-based superalloys. (Image: JR Machine)

Background Image: Bird_Saranyoo/Adobe Stock

JR Machine recently built a state-of-the-art Engineering Room, where it programs all jobs and conducts design for manufacturing assessments. (Image: JR Machine)

JR Machine positions its DMG MORI CNC turning centers in a cellular arrangement to make machining complex parts more efficient. (Image: JR Machine)

The tooling storage room allows machine operators to quickly check out the necessary tooling, while automatically updating inventory records. It holds "the thousands of tooling inserts we need to meet specs and hit our delivery deadlines," the company's website notes.

During the COVID-19 pandemic, JR Machine shifted its focus to the aerospace and defense market, and has been capturing some of the growth in space launches and operations in recent years as well. The company operates an International Traffic in Arms Regulation (ITAR)-certified shop, that also has ISO 9001:2015- and AS9100D- certifications.

"Around 2020, we started targeting the aerospace market a lot more, and were able to use some of the downtime during COVID to obtain our AS9100 certification. We also hired Strother Communications Group to rebrand the company to give us an aerospace look," Tim Tumanic, the founder of JR Machine, told *A&DT* during an interview recorded remotely with other members of the JR Machine leadership team from their facility in Wisconsin.

"Now, here we're, moving into 2025 and we're working with six or seven of the top 10 launch companies in the world. Our goal within the next few years is to achieve 50 to 60 percent of our business being attributed to space and defense related work," Tumanic added.

JR Machine's All DMG Mori CNC Machine Strategy

Every CNC machine at JR Machine's facility is from the DMG Mori portfolio of turning and machining centers. DMG Mori is the international Japanese provider of a wide range of CNC machines capable of everything a company like JR Machine needs from universal turning and 5-axis simultaneous machine to ultrasonic machining of advanced materials and metallic 3D printing.

Their machines come with a suite of digital tools that allow technicians to use CAD software to design a part, G-code an instruction set for the toolpath movements required to machine the part and select the appropriate cutting tool, according to an overview provided by DMG Mori. Each machine is also equipped with software that monitors its performance and provides alerts for anticipated or needed repairs.

Tumanic also notes that troubleshooting for their machines can be performed remotely when needed.

"Many years ago we had several different brands and types of machines in our facilities, and we found having that many different brands can prevent continuity," said Parker Tumanic, President, JR Machine. "Having continuity helps, because you can train one operator and give them the ability to run all our machines rather than training them to run five different types, or only having one operator that can run certain type of machines."

In 2024, two new machines, DMG MORI NLX 4000 CNC turning centers, were added to their Shawano

facility. The additional machines expands JR Machine's production capability to parts measuring up to 18-inches in diameter. Their previous limit was 10 inches.

DMG Mori describes the NLX 4000 as featuring built-in motor turret technology with improved milling power and the "largest through spindle hole diameter in its class: 5.7 in/7/3 in."

Parker said the decision to upgrade to the NLX 4000 was driven by several factors.

"Our current NLX 2500 and NLX 4000s are essentially lathes with live tooling, and they're more geared for parts that are about 80 percent lathe work and 20 percent live tooling. The NTX 2500 is more of a true mill turn machine rather than a lathe with live tooling," he said. "On the NTX 2500, it's capable of about 50 percent lathing operations and 50 percent milling operations. We wanted to increase our capabilities to our customer base. We thought this was the right type of machine because that's what we're hearing in the industry. We also wanted to stick to the closest commonality available. It's still a DMG MORI, the software and controls are still the same, and we get added capabilities."

JR Machine completes inspections on all part dimensions in its Quality Assurance Lab. (Image: JR Machine)

Machining Complex Parts, Materials for the Space Industry

A major portion of the parts and components being developed by JR Machine's DMG Mori equipment are purchased by companies that perform space flight and exploration. The company also provides parts and components for weapons and defense platforms.

These components include engine and hydraulic components; a variety of flanges for fuel, gas and other fluid delivery and movement; and many other round complex components within space systems.

"Looking at the space market, right now we're heavily involved in machining components that are necessary for engines, ranging from simple components like flanges up to some of the more complicated ones like valves," said Michael Ross, Vice President of Business Development and Sales. "As we progress and grow our capabilities, we're looking at some of the more advanced turbomachinery components. We've also done some of the intake and ducting components for engine fuel."

The company's shift into machining parts for spacecraft occurred at a great time, as both the commercial and defense segments of the space industry continue to grow. In the U.S. alone, there were 148 licensed commercial space operations in 2024, a new record, according to data published by the Federal Aviation Administration in November 2024.

That was up from 117 in the previous year. SpaceX completed 134 of those launches, and is targeting and increase in launches in 2025.

"The reason why we're shifting some of our focus to defense and space, is that we have established an expertise in working with the more difficult materials, the various superalloys and the very hard materials that are used in space and defense platforms," Ross said. "Some of those materials that are difficult to machine include Inconel and Monel."

According to JR Machine's website, Inconel is a family of nickel-chromium superalloys that provide resistance to corrosion and oxidation at the extreme temperatures of space. The material is often used in rocket engines, turbine blades and exhaust systems.

Monel, the company explains, is a nickel-copper alloy that also has high resistance to corrosion, including within marine environments. Monel can be found in space applications such as valves, fittings, and electrical connectors.

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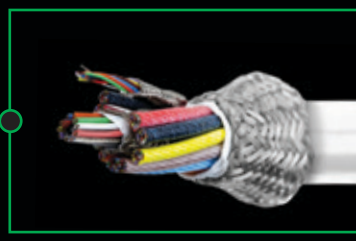

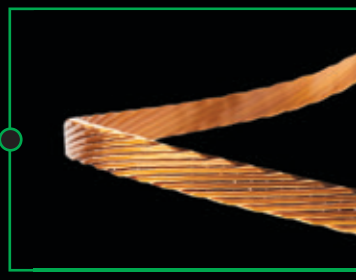

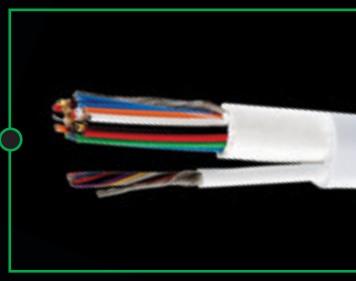

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Hastelloy, a nickel-chromium-iron-molybdenum superalloy known for its high temperature strength, is another material that gets machined in Shawano. JR Machine has machined parts consisting of Hastelloy that are featured in rocket engines, heat exchangers and combustion engines, among other spacecraft applications.

JR Machine installed two DMG MORI NLX 4000 CNC turning centers in the spring of 2024, allowing it to machine parts up to 18-inches in diameter. (Image: JR Machine)

"The space industry has a major need for high strength, high temperature resistant materials, and high corrosion resistant materials as well, because low earth orbit is a very corrosive environment, certainly much more so than any place on our planet. Our ability to build corrosion-resistant, high strength materials has really led our strategy in space, and it is what leads us into some of our work with defense because those materials are used there as well," Ross said.

While 2024 was another year of growth and expansion for JR Machine, the company plans to continue that expansion well into the future. In May 2024, the company established a new investment partnership with Schneider Resources Holding (SRH), a private investment firm headquartered in Green Bay, Wisconsin.

Tim Tumanic, the company founder, said that they're following a strategy that considers upgrading to new generations of CNC machine technology every 10 years. While DMG Mori does currently provide additive manufacturing equipment and tools, CNC machines remain the current focus for JR Machine.

"I think one of the biggest things that our customers are looking at when it comes to additive subtractive, and subtractive machining is that when you add a feature to an existing part like a billet, and print a feature on it, you must ensure that the integrity of the metal that you're printing is the same as the billet material. No one is quite convinced, yet that additive manufacturing can achieve that," Tumanic said. "This really applies to high temperature, nickel-based materials which are mission critical and cannot have failure points. Nobody's really willing to take that risk quite yet. I think as the technology evolves, there will eventually be a place for us in additive. However, as of right now, we haven't been able to convince customers of that."

This article was written by Woodrow Bellamy III, Senior Editor, SAE Media Group (New York, NY).

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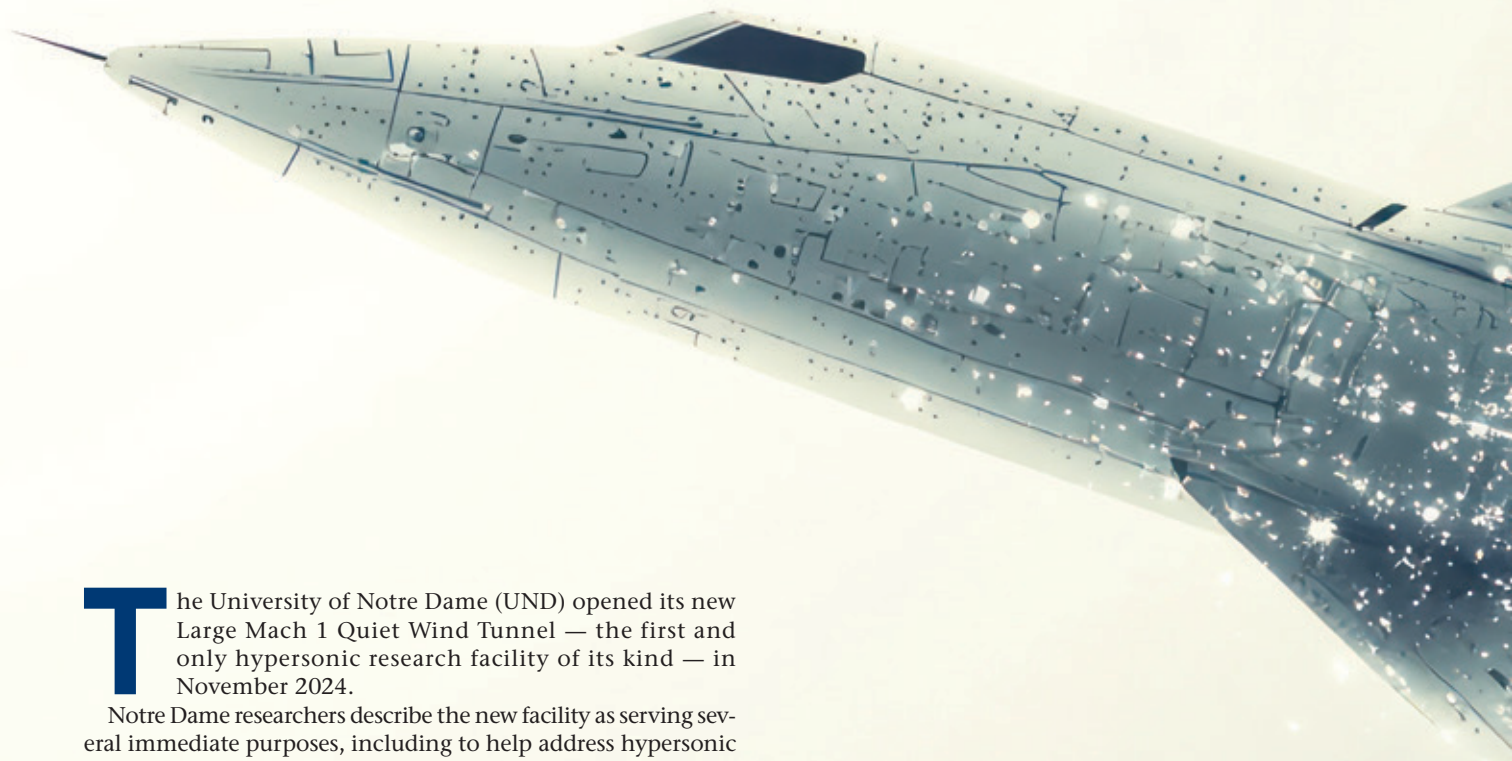
Notre Dame's New Boundary Breaking Mach 10 Quiet Wind Tunnel



The University of Notre Dame (UND) opened its new Large Mach 1 Quiet Wind Tunnel — the first and only hypersonic research facility of its kind — in November 2024.

Notre Dame researchers describe the new facility as serving several immediate purposes, including to help address hypersonic testing backlogs at Department of Defense (DoD) facilities. It can also be used to help aerospace companies move from hypersonic vehicle concepts to prototypes, and will support a planned graduate program in hypersonic systems for the university.

The Large Mach 10 Quiet Wind Tunnel is the latest aerospace research facility to join Notre Dame's campus, which also includes the Hessert Laboratory for Aerospace Research and Hessert at White Field, the Institute for Flow Physics and Control (FlowPAC), and NDTL Propulsion & Power. The tunnel is also the latest expansion of Notre Dame's Hypersonic Systems Initiative that the university describes as an effort to engage its broad engineering and science expertise while also addressing "the technical challenges of developing efficient, hypersonic flight vehicles."

Notre Dame's Hypersonic Systems Initiative includes research focused on hypersonic aerodynamics, energy storage, flight control, manufacturing and materials among others. Hypersonic research and development, along with developing the future hypersonic workforce, has remained a priority for the university's Hypersonic Systems Initiative and its various research facilities and capabilities on campus as well. As an example, in a December 2022 article written by the university's media team, it was noted that Atlanta-based startup Hermeus used their turbo machinery laboratory to test the ability of their Chimera hypersonic prototype engine to transition from turbojet to ramjet mode.

The opening of the new facility occurs amid an ongoing push by the U.S. military to develop hypersonic weapons and technologies. In December, for example, DoD published an update highlighting the completion of an end-to-end flight test of a conventional hypersonic missile from Cape Canaveral Space Force Station, Florida. The test was part of an ongoing collaboration between the U.S. Army and Navy to develop and field hypersonic missiles, known as the Common Hypersonic Glide Body (C-HGB). In November, the Joint Hypersonics Transition Office (JHTO) concluded its "Hypersonic Accelerated Manufactured Prototype Demonstration" challenge by issuing awards to Castelion Corporation and Specter Aerospace to produce novel new hypersonic prototypes.

The new Large Mach 10 Quiet Wind Tunnel was designed by Thomas Corke, Notre Dame's Clark Equipment Professor of Aerospace and Mechanical Engineering, along with doctoral students Joseph Heston and Jacob Caldwell.

Check out our question and answer session with Corke below, where he provides *Aerospace & Defense Technology* (A&DT) with an understanding of some of the unique design, manufacturing and materials related challenges that the new facility could help the industry resolve in the quest to develop hypersonic flight vehicles of the future.

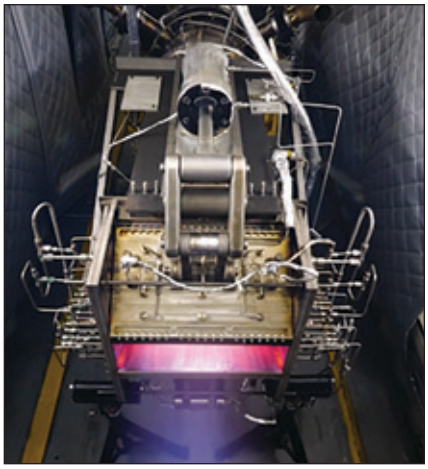
***Aerospace & Defense Technology (A&DT):* What are some of the main elements of the facility that allows it to function as a "quiet" wind tunnel?**

Thomas Corke: The concept of "quiet" tunnels comes from the observations in the 1980s at NASA Langley that there were differences in the location of turbulence onset in the boundary layers at supersonic Mach numbers over test articles between wind tunnel tests and flight tests. These differences were attributed to disturbances in the wind tunnel that were not present in flight. This led NASA Langley to design a

The Large Mach 10 Quiet Wind Tunnel was designed by Thomas Corke, Notre Dame's Clark Equipment Professor of Aerospace and Mechanical Engineering, pictured here. (Image: University of Notre Dame)

Background Image: Almahyra/Adobe Stock

The facility held an opening day ceremony, with university researchers and members of Congress in attendance. Pictured: Front (left to right): Congressman-elect Tony Wied, Congressman Pat Fallon, Chairman Mike Rogers, Dean Patricia Culligan, Vice President for Research Jeff Rhoads, Professor Tom Corke, Admiral Christopher Grady, Major General Michael McCurry, Ambassador Joe Donnelly, and Mayor James Mueller. Back (left to right): Doctoral Students Jacob Caldwell, Alec Jobbins, Will Jordan, Nicholas Hawley, Joseph Heston, Tim Moren, and Alyssa Spencer. (Image: Angelic Rose Hubert)



In 2022, Atlanta-based hypersonic startup Hermeus used Notre Dame's Turbomachinery Lab (NDTL) to test its Chimera engine, pictured here at the facility. (Image: University of Notre Dame)

Mach 3.5 (proposed Mach number of the Supersonic Transport) nozzle that suppressed instabilities of the boundary layers that would develop over the nozzle wall surfaces that would lead to the disturbances (pressure fluctuations) that were not present in flight and would affect turbulence onset on the test article. This has motivated all of the quiet tunnel development that followed to the present.

NASA Langley also developed a Mach 6 quiet nozzle in the late '90s that was eventually put in storage but later given to Texas A&M university. Purdue built a Mach 6 quiet tunnel that has been in operation for the past 15 years. Both of these facilities are small in scale and cannot reach Reynolds numbers where transition to turbulence will occur. This is a serious limitation as the object of these facilities is to predict turbulence onset.

At hypersonic Mach numbers, the onset of turbulence results in from 3 to 5 times higher surface heating. Failing to predict if and where this occurs is critical to hypersonic aircraft design. This limitation motivated the development of the quiet tunnels at Notre Dame, namely, to develop quiet hypersonic wind tunnels of a scale that can produce conditions that would result in turbulence onset on test articles. Regarding quiet tunnel design, Mach 6 is a relative "sweet spot" where requirements such as air temperature and pressure are not excessive. NASA Langley attempted to build a Mach 8 quiet tunnel that failed because of degradation of the nozzle metal that resulted from the required higher air temperatures. Before our design, no one has attempted or possibly considered a Mach 10 quiet tunnel.

A&DT: Why Mach 10?

Corke: Regarding powered (scramjet) hypersonic vehicles, at a given Mach number there is a maximum altitude at which combustion can occur. At Mach 6, this is about 31km. To fly at higher altitudes, the vehicle needs to travel at a higher Mach number. This generally motivates the development of higher Mach number facilities.

The other reason for developing a Mach 10 quiet tunnel, whereas Mach 8 would have been easier, is that there are fundamentally different boundary layer transition physics that affect turbulent onset at Mach 10 that does not exist at Mach 6 or 8.

The Notre Dame Mach 10 Quiet Tunnel has a large test section that can accommodate large test articles. This allows a scale of test articles over which turbulence onset can occur. This also allows large test articles used in large conventional (noisy) government hypersonic tunnels to be similarly tested in the Notre Dame quite wind tunnel. This provides a significant cost reduction to a program that can evaluate on the same test article, if the disturbance levels are important to the turbulence onset predictions.

Another design element of the Mach 10 quiet tunnel is that it does not use a "burst plate" to initiate the flow. This has a number of advantages including allowing a large test section, thin optical windows, and a rapid tempo (order of minutes) tunnel operation. Rather than typical 2-3 runs per day with burst plates, the ND design allows hundreds of runs per day.

A&DT: How can the research at this facility help to advance hypersonic technology for the aerospace and defense industry?

Corke: The wind tunnel is designed for both fundamental research as well as test and evaluation. Fundamental research generally involves somewhat generic test articles. These experiments are also generally coupled with numeri-

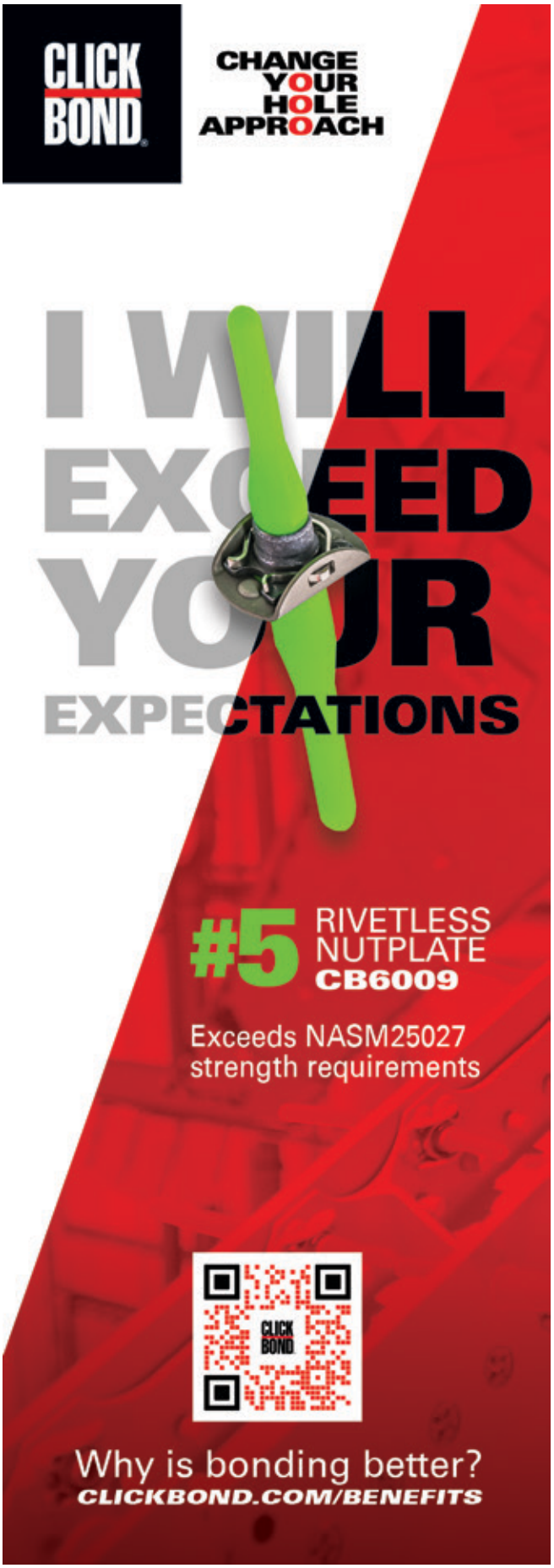
cal flow simulations. Test and evaluation will generally involve proprietary and classified geometries. In that case, the large scale of the facility allows can accommodate full-scale designs. The rapid tunnel operation tempo makes test and evaluation highly efficient.

Hypersonic flight within the atmosphere involves a large number of technologies. These include high-speed aerodynamics, flight control, high temperature materials, heat mitigation and transport, structures, manufacturing, propulsion, communications, energy conversion and storage, and systems monitoring and diagnostics. Experiments in the Mach 10 facility can be designed to directly address a number of these including high-speed aerodynamics, flight control, heat mitigation and transport, and propulsion.

***A&DT:* Over the last year, Department of Defense officials have repeatedly stated their need for more cost effective methods for developing and testing hypersonic weapons and vehicles. How can the new Mach 10 Quiet Wind Tunnel help the industry overcome some of the costs associated with development?**

Corke: The tunnel follows a Ludwieg tube concept. By eliminating the burst plate, very little air is discharged during a run. This air can be recharged in 1-2 minutes allowing the rapid tempo previously discussed. Eliminating the burst plate is not only a time saving, but also a cost savings. For the operating conditions and scale of the Mach 10 tunnel, the burst plates

In December 2024, the U.S. Army's Rapid Capabilities and Critical Technologies Office, in collaboration with the U.S. Navy Strategic Systems Programs, completed a conventional hypersonic missile test from Cape Canaveral Space Force Station, Florida. (Image: Department of Defense)



would cost many thousands of dollars and are not reusable after a single run.

Another cost-saving feature of the design is that the large test section will allow multiple test articles to be tested simultaneously.

***A&DT:* How can the facility aid in the development of the new types of materials that would be necessary to withstand the type of heat transfer rates that exist for vehicles that are performing hypersonic flight at Mach 10?**

Corke: The Mach 10 tunnel is a so-called "cold tunnel". Although it has a high stagnation temperature, the static temperature at Mach 10 is quite low static temperature. Therefore, it is not the right facility for high-temperature material testing. Facilities that are designed for such high-temperatures are "Arc-heated Jet" facilities. Notre Dame has a smaller scale variable Mach number Arc-Jet Facility where such research can be performed.

Where the Mach 10 facility can impact the surface heat flux on hypersonic vehicles is on developing methods for delaying or preventing turbulence onset on the vehicle acreage and flight control surfaces. This is an area of research where Professor Corke's Group at Notre Dame is well known.

***A&DT:* The Hypersonic Systems Initiative section of Notre Dame's website notes that producing hypersonic systems is a challenge because of "the greater degree of thermal protection and inherent complications produced by hypersonic flight." How could the research conducted at the new wind tunnel help design and manufacturing engineers overcome this thermal protection challenge?**

Corke: There are a number of thermal protection approaches, both passive and active. The Mach 10 tunnel is best suited to active approaches in which the flow field has a role. One such approach involves "transpiration cooling" in which a cooled fluid ranging from water to supercritical CO_2, are injected through a porous surface at the leading edge. This has proved to be highly effective in reducing the high surface temperatures making it possible to use conventional leading-edge materials.

Transpiration cooling can also be coupled with thermal-electric conversion approaches where the cooling fluid plays a double role by using it to establish the "cold junction". The lower temperature maintenance of the cold junction determines the thermal-electric conversion efficiency.

This article was written by Woodrow Bellamy III, Senior Editor, SAE Media Group (New York, NY).

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Shape-Shifting Antenna Poised *to Transform Communications*

By leveraging cutting-edge additive manufacturing techniques and shape memory alloys, researchers at the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland, have created an antenna that can change its shape based on its temperature. This technology — described in a recent online publication in ACS *Applied Engineering Materials* and which will be featured on the cover of an upcoming print issue — has transformative potential in a wide range of military, scientific and commercial applications.

The shape of an antenna's front end dictates many of its operating parameters. Once it's manufactured, those characteristics are locked in. A shape-changing antenna would enable communications across a wider array of radio-frequency (RF) bands, opening up new realms of operational agility. Among the possibilities, a single shape-shifting antenna could do the work of multiple fixed-shape antennas, adapt dynamically to spectrum availability and change beamwidth to switch between short- and long-range communications.

Inspired by science fiction technology, the novel antenna is the result of creative cross-disciplinary collaboration across APL.

Electrical engineer Jennifer Hollenbeck said she got the idea from "The Expanse" series, where alien technology is organic and shape-changing. "I have spent my career working with antennas and wrestling with the constraints imposed by their fixed shape," she said. "I knew APL had the expertise to create something different."

In 2019, Hollenbeck reached out to Steven Storck, now chief scientist for additive manufacturing in the Lab's Research and Exploratory Development Department, who at the time led an Independent Research and Development project to create a promising methodology to additively manufacture shape memory alloys. These unique materials deform at lower temperatures but return to a "remembered" shape when heated and are used in a wide variety of applications, ranging from medical uses such as orthodontic wires, vascular stents and bone implants to actuators for control surfaces in spacecraft.

Mechanical engineer and materials scientist Andy Lennon had used nitinol — a shape memory alloy of nickel and titanium — to create coils that would extend down through a person's esophagus to assist with heart imaging. As Lennon and others worked on applications for nitinol, a desire arose to 3D-print complex shapes with it. But that presented a problem: Nitinol and other shape memory alloys conventionally require extensive mechanical processing — known as cold work — to achieve the shape memory effect, and as a result they are typically only available as wire or in thin sheets.

"Doing an extreme amount of cold work would defeat the whole point," Lennon said. "If you take that complex shape and pass it through a die to stretch it out, you're back to a wire."

The APL team initially conducted research to tackle the fundamental challenges associated with scalable additive manufacturing of nitinol components, later applying these techniques to create shape-changing structures that could be deployed in space applications. After extensive experimentation toward the antenna application, the team altered the ratio of nickel and titanium, but the first attempt to create a shape-shifting horn antenna using 3D-printed nitinol fell short. While the antenna did technically expand and contract and change its frequency, it was also rigid and difficult to expand.

"It turned out to be a really complicated design, and it didn't work as well as I would have liked," Hollenbeck said.

Undeterred, Hollenbeck and the team submitted a proposal for a Propulsion Grant, one of APL's internal funding opportunities designed to support the development of revolutionary solutions to critical challenges.

By leveraging cutting-edge additive manufacturing techniques and shape memory alloys, APL researchers have created an antenna that can change its shape based on its temperature. (Image: Adobe Stock)

This time, Hollenbeck had a new antenna design in mind. Lennon's team had been able to 3D-print nitinol with what's known as two-way shape memory, in which the alloy can be heated and cooled to alternate between two remembered shapes. With critical design and prototyping support from Kyle Sibert, an electrical engineer in APL's Force Projection Sector, Hollenbeck's team developed an antenna that was shaped like a flat spiral disk when cool but became a cone spiral when heated.

Heating the spiral proved to be a challenge. The team had to determine how to heat the metal of the antenna enough for it to change shape, but without interfering with the RF properties or burning out the structure. To solve the problem, the team, led by RF and microwave design engineer Michael Sherburne, had to invent a new form of power line.

"For peak heating, the power line has to handle a lot of current," Sherburne

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said. "We had to go back to fundamentals to make this work."

The final piece of the puzzle was working out how to 3D-print the antenna in a consistent, repeatable fashion. Lennon's modified nitinol, with its higher concentration of nickel, made it challenging to print at scale.

"We have a lot of experience optimizing processing parameters and designs for alloys, but this was a step beyond," explained additive manufacturing engineer Samuel Gonzalez. "There aren't many people out there, if anyone, printing this material, so there's no recipe for how to process it."

"We made shrapnel in the printer a few times because the antenna is trying to change shape as you're printing it, due to the heat," added colleague Mary Daffron. "It wants to peel apart."

Typically, the team can process an alloy in less than four days, but Daffron and Gonzalez said this particular material took two to four weeks of build time.

Now that they have optimized the processing parameters, they're already looking for ways to build on their initial success.

"We want to optimize the parameters to work on multiple different machines, to make this more widely applicable, and we know we'll need to optimize for different variations of the material that might actuate at different temperatures," Daffron said.

The hard work put in by teams across APL has yielded a radically innovative technology that could have wide-ranging applications, supporting special operators in the field, mobile network telecommunications and even space missions to distant celestial bodies.

APL is pursuing a full patent on behalf of the team for the shape-adaptive antenna technology. The Lab has also provisionally decided to pursue patents for the novel power line for heating the spiral, a method for controlling the antenna, and a method and process for using shape memory alloys to create a phased array antenna.

"The shape-shifting antenna capability that has been demonstrated by this APL team will be a game-changing enabler for many applications and missions requiring RF adaptability in a low-size and -weight configuration," said APL Chief Engineer Conrad Grant. "This is yet another powerful example of the innovation that occurs at the Laboratory through motivated, highly capable, multidisciplinary teams."

This article was written by Ashley Hume and Ajai Raj for the John Hopkins Applied Physics Laboratory (Laurel, MD). **For more information, contact Amanda.Mantiply@jhuapl.edu.**

British Army Completes First Test of Drone Killing Radio Frequency Weapon

British soldiers have successfully trialed for the first time a game-changing weapon that can take down a swarm of drones using radio waves for less than the cost of a pack of mince pies.

The Radio Frequency Directed Energy Weapon (RFDEW) development system can detect, track and engage a range of threats across land, air and sea.

RFDEWs are capable of neutralizing targets up to 1km away with near instant effect and at an estimated cost of 10p per shot fired, providing a cost-effective complement to traditional missile-base air defence systems.

The RFDEW is different from Laser Directed Energy Weapons – such as DragonFire - because it uses a radio frequency to disrupt hostile threats, rather than a laser beam of light energy.

The weapon uses high frequency waves to disrupt or damage critical electronic components inside devices such as drones, causing them to be immobilized or fall out of the sky. It can also be used against threats on land and at sea.

The British Army successfully trialed a demonstrator version of the RFDEW. The development system has been produced by a consortium led by Thales UK and including sub-contractors QinetiQ, Teledyne e2v and Horiba Mira and supports up to 135 high-skilled jobs in the UK.

This progress helps deliver on the Government's Plan for Change by rapidly advancing technologies and building on the strong foundation of national security.

Its high level of automation means the system can be operated by a single person and could be mounted onto a military vehicle, such as a MAN SV, to provide mobility.

"The successful firing by the British soldiers of our Radio Frequency Directed Energy Weapon is another step forward for a potentially game-changing sovereign weapon for the UK," Minister for Defense Procurement and Industry, Maria Eagle MP, said in a press release. "It's great to see defence experts and industry working collaboratively to put cutting-edge equipment in the hands of our Armed Forces. This is demonstration of the UK remaining at the forefront of directed energy weapons and developing a crucial advantage against the emerging threats we face."

The Radio Frequency Directed Energy Weapons (RFDEW) demonstrator mounted to a British Army truck. (Image: UK Ministry of Defense)

A live firing trial was recently completed by the Army's Royal Artillery Trials and Development Unit and 7 Air Defence Group at a range in West Wales, where they successfully targeted and engaged uncrewed aerial systems (UAS), in a first for the British Armed Forces.

The user experimentation trials completed in recent months have enabled Army air defence personnel to explore and exercise the capability's potential in different configurations across a variety of range environments, threat types and engagement scenarios.

This activity follows the development process announced back in May and delivered by Team HERSA - a joint enterprise between UK MoD's Defence Equipment & Support and Defence Science and Technology Laboratory (Dstl).

"Getting this technology into the hands of our service personnel is hugely rewarding," said Dstl Program Lead, Matt Cork. "Dstl has worked collaboratively with DE&S and industry which has meant the rapid evolution of radio frequency technology."

This latest trial marks a pivotal moment in the UK's ongoing efforts to enhance the future operational capabilities of the Armed Forces and offers a precise, powerful, and cost-effective means to defeat multiple aerial threats.

The trials program will continue to enable further development and experimentation, while Team HERSA continues to work with operators to develop RFDEW requirements, doctrine and technology, shaping the next generation of mission-optimized RFDEWs.

This article was written by a team of researchers and engineers for the UK Ministry of Defense Science and Technology Laboratory (London, UK). **For more information, visit https://www.gov.uk/defence-and-armed-forces.**

A Swarm of Sensors, Rovers and Astronauts Explore the 'Moon'

Researchers at the German Aerospace Center have developed a new approach to networked communications that could theoretically occur on the Moon or in environments on Earth where conventional communications are unavailable.

German Aerospace Center, Köln, Germany

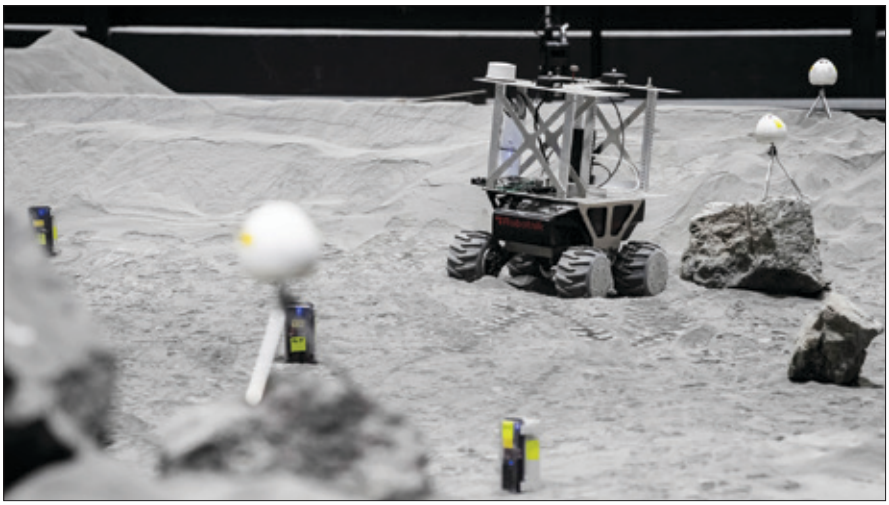
Golden packages on the Moon? Not exactly. This is no extraterrestrial gift depot, but a cutting-edge project in the LUNA hall. Here, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) has been researching how payload boxes, sensors, rovers and astronauts can connect to form an integrated network. These participants, or nodes within the network, exchange signals that facilitate both communication and navigation.

"Every robot, sensor or astronaut becomes a participant in the network, passing on information to its neighbors. We calculate the distances between participants by measuring the time it takes for radio signals to travel between them. Using this method, we can determine the exact positions of all participants within the network," explains Emanuel Staudinger, project manager at the DLR Institute of Communications and Navigation. "The system is decentralized, requires no infrastructure and is designed to accommodate a large number of participants." The swarm navigation network developed by the institute could be used to explore the surfaces of the Moon and Mars. It is also effective in environments on Earth where conventional systems such as satellite navigation are not available, for example in lava caves or other complex terrains.

Robots Working Together

Staudinger and his team have spent recent years testing the swarm navigation network in diverse terrains, including Mount Etna in Italy and a lava cave on Lanzarote, Spain. Now, for the first time, the swarm navigation network has been successfully tested in the LUNA hall, which simulates a realistic lunar environment. Opened at the DLR site in Cologne in September 2024, LUNA simulates conditions on the lunar surface. "The research center – a joint project between DLR and the European Space Agency (ESA) – is designed to prepare astronauts and robots for Moon missions," explains Thomas Uhlig from the LUNA project management team. "Our colleagues from the DLR Institute of Communications and Navigation are among the first to conduct research here. We've already received numerous requests from a wide range of fields for access to LUNA. The future looks exciting."

In the LUNA hall, scientists from the institute in Oberpfaffenhofen demonstrated several scenarios, including one in which a lander arrives on the lunar surface and deploys two rovers. The first rover was tasked with placing radio beacons around the lander. These sensor



A rover moves between sensors and stones in the LUNA hall. (Image: German Aerospace Center)

Exploring the Moon in the dark. (Image: German Aerospace Center)

units immediately then assumed navigation tasks. During its exploratory trips, the rover discovered a crater but realized it could not descend into it, so called for assistance from the second rover. This crater is located in a section of the LUNA hall where the floor has been lowered three meters. Using the navigation system, the second rover found its way to the crater on its own and carried out scientific investigations. As it descended, the first rover assisted from the crater's edge, guiding the second rover with navigation data. Another scenario involved deploying sensor units in an area too steep for a rover to traverse. Here, up to 50 sensors were distributed and interconnected to form a navigation network. The team also tested flying units or dropping the sensors into an inaccessible crater.

3D Model of the Regolith Surface Created

In addition to the navigation experiments, the team developed a 3D model of the LUNA floor to support simulations and validate measurement data. A significant portion of the hall is covered with a layer of regolith simulant, or 'Moon dust'. This material mimics the chemical, physical and geological properties of the regolith samples brought back to Earth by the Apollo missions.

The research team from the DLR institute will now analyze the data in detail and continue refining the swarm navigation network. The ultimate goal is to provide robust, decentralized navigation and communication capabilities for astronauts and robots exploring the Moon. These advancements could also prove invaluable for terrestrial missions in challenging and inaccessible environments.

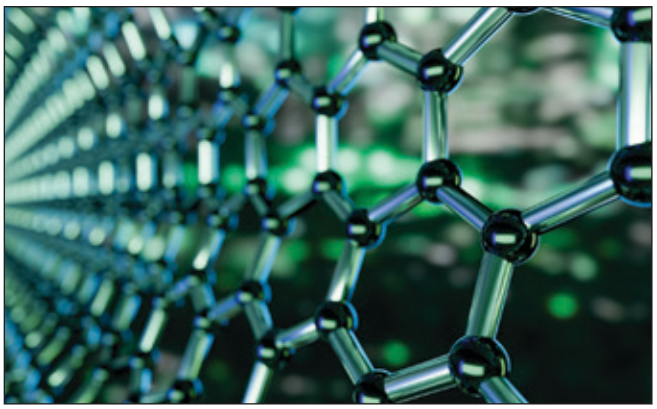
This article was written by a team of researchers for the German Aerospace Center. **For more information, visit www.dlr.de.**

Army Researchers Examine Nanotechnology for Climate Solutions

Army scientists are joining forces with experts from across the nation to tackle the climate crisis using the power of nanotechnology.

Army Research Laboratory, Aberdeen Proving Ground, MD

As part of the Nano4 EARTH initiative, a national challenge launched by the White House and the National Nanotechnology Initiative, researchers are exploring how innovations at the nanoscale can lead to groundbreaking solutions for a more sustainable future.



U.S. Army scientists are joining forces with experts from across the nation to tackle the climate crisis using the power of nanotechnology. (Image: Shutterstock)

Climate change poses a significant threat to national security, according to the Army's published Climate Strategy. The Army has committed to aggressive goals to mitigate its own impact, including a 50 percent reduction in net greenhouse gas pollution by 2030 and net-zero emissions by 2050. Nanotechnology is seen as a critical tool in achieving these ambitious targets.

In a recent paper in the journal *Nature Nanotechnology*, co-author Dr. Mark Griep, a researcher with the DEVCOM Army Research Laboratory, said nano-enabled climate solutions are already transitioning to industrial scale-up, which will help reduce the "green premium" that can be a limiting factor for widespread public adoption.

"The climate crisis demands bold, innovative solutions, and nanotechnology offers a unique opportunity to achieve the kind of step-changes needed to mitigate its effects," Griep said. "By working collaboratively across sectors, we can harness the power of nanotechnology to create a more sustainable and resilient future for the Army and the nation."

According to Griep, metal organic frameworks, known as MOFs, are being scaled up for greenhouse gases capture applications and should exceed the Department of Energy's EarthShot carbon capture costs below $100 per ton and become a cost-effective technology.

Griep said he believes the Army can engineer MOFs with catalytic functions for CO2-to-fuel opportunities.

"This would allow for nano-enabled solutions that not only contribute to decarbonizing the Army fleet but simultaneously enabling operational advantage through new fuel sources," he said.

The Nano4EARTH initiative identified four strategic areas where nanotechnology research aims to address climate change challenges, according to program documents.

The program focuses on batteries and energy storage, where researchers are studying nanomaterials for potential applications in electric vehicle batteries

and grid storage systems. According to the Army Climate Strategy, such advances in energy storage technology could support goals for electrifying the transportation sector.

The second focus area examines nanocatalysts for industrial processes. Laboratory studies have shown these materials can potentially improve efficiency in manufacturing processes, including those used in steel, cement and plastics production. Researchers are also investigating methods to convert captured greenhouse gases into other products.

Interface research represents the third strategic area. Scientists are studying how nanotechnology could improve energy efficiency in coatings, lubricants and membranes. Current research includes work on thermal interface materials for electronics and membrane systems for industrial separations.

The fourth area concentrates on greenhouse gas capture and storage technologies. Research teams are investigating MOFs, which are nanoporous materials designed to absorb CO_2. Additional studies examine nanomaterials for carbon sequestration in terrestrial and marine environments.

The initiative emphasizes modifications to existing technologies rather than developing entirely new systems. This approach aligns with the Army's stated objectives for implementing climate change mitigation strategies, as outlined in the climate strategy document.

The laboratory's participation in Nano4EARTH highlights the military's commitment to combating climate change, Griep said, not just through operational adaptations but through cutting-edge scientific research.

By leveraging the unique properties of nanomaterials, researchers aim to develop solutions that can transform industries, reduce dependence on fossil fuels, and ultimately mitigate the risks posed by a changing climate, he said.

"The Army is in a unique position to be an innovation leader for climate change solutions as the advanced technologies for achieving climate goals go hand-in-hand with increasing combat effectiveness," Griep said. "Nano-enabled advancements to energy storage, water purification, and advanced structural materials will be game changers in the civilian world but play an even more crucial role in ensuring the Army's operational resilience and capabilities in future combat environments."

This article was written by the U.S. Army Combat Capabilities Development Command Army Research Laboratory (DEVCOM ARL). **For more information, visit https://arl.devcom.army.mil/.**

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Airman Brings Fuel Sampling Innovation to Eglin, Possibly Air Force

The U.S. Air Force is testing a new prototype single point nozzle adapter that drastically reduces the time required for jet fuel quality sampling.

Air Force Research Laboratory, Eglin Air Force Base, FL

With a few of snaps, turns and clicks, a new fuel innovation is sealed in place to an Air Force R-11 fuel truck. After that five-second attachment, it is ready to gather a required fuel sample for evaluation to ensure aircraft fuel is free of water or any other contamination.

This innovation, known as the single-point nozzle adapter, or SN, removes two-thirds of the time and steps required to take a fuel sample from multiple fuel sources, such as trucks and mobile stations. It also removes almost any chance of direct exposure, from spillage or spray to the hazardous chemicals that make up the fuel.

Only two of the SN prototypes exist, but thanks to the 96th Test Wing's iSpark, Eglin will become the third base to have, not just one, but three of the $2,700 adapters. This SN innovation is the idea of Tech. Sgt. Collin Stratton, a fuels support NCO-in-charge with the 96th Logistics Readiness Squadron.

Stratton brainstormed the idea in March 2022 while working in the Kadena Air Base, Japan fuels lab, where fuel samples are quality tested each day.

"I just kept thinking, there's got to be a faster or easier way to take these samples," said the 28-year-old Arizona native. "I tried to put something together from extra equipment that might allow me to pull a fuel sample from a truck without taking the hose apart and I realized that piece did not exist."

After a visit to the Kadena AB innovation shop, the base metals shop helped him draft up specifications for a possible new piece of equipment that would connect directly to the fuel source and the hose that distributes the fuel.

He took those specifications to the fuel hose manufacturer, Cla-Val's product development team and explained the need for this new tool.

Cla-Val created a prototype while Stratton and his flight pushed for Air Force Petroleum Agency approvals to test the adapter on the fuel equipment. When the prototype arrived, it was essentially a modified fuel nozzle, adapter and fuel sampler combined. Stratton's Kadena unit began testing in the summer of 2023.

Stratton's idea and prototype worked right away removing more than 20 steps from the fuel sampling process checklist. This, in turn eliminated the time, tools and tedium of disassembling part of the fuel hose to open a thumbnail-sized valve and reassemble it once sampling was complete.

"Once we put it together, we realized it was the perfect piece of equipment to remove all those steps we were doing," said Stratton, who added he was inspired to improve fuel processes because petroleum, oil and lubricants is the reason why the aircraft fly. "We can now pull a fuel sample from any equipment using a single-point nozzle to distribute aviation fuel worldwide."

While waiting for his prototype to arrive, Stratton deployed to southwest Asia and discovered the same sampling issues in the deployed environment where agile combat employment is critical. He took his adapter idea to the POL unit there and soon a second SN adapter prototype arrived at his deployed location. It was during the deployment, he discovered how valuable the SN adapter

Tech. Sgt. Collin Stratton, 96th Logistics Readiness Squadron, holds his new innovation, the single point nozzle adapter Nov. 6, 2024 at Eglin Air Force Base, Florida. The SN adapter, an innovation created by Stratton, makes fuel sampling easier and safer by reducing the steps required to gain the sample. Fuel samples are taken to ensure aircraft fuel is free of water and other contaminants. (Image: U.S. Air Force)

Stratton secures his single-point nozzle adapter to an R-11 fuel truck Nov. 6, 2024 at Eglin Air Force Base, Florida. The SN adapter, an innovation created by Stratton, makes fuel sampling easier and safer by reducing the steps required to gain the sample. Fuel samples are taken to ensure aircraft fuel is free of water and other contaminants. (Image: U.S. Air Force)

could be to POL Airmen working in joint and coalition environments.

Stratton's SN adapter allows POL Airmen to pull a fuel sample from other services and country's distributors and test it to ensure their fuel is safe for Air Force aircraft. That capability did not exist in an AFPA-approved form before the SN adapter.

"The jet fuel we use in Air Force aircraft has very specific standards and properties it must meet. If we don't have the capability to sample other organization's fuel, we could be issuing fuel that doesn't meet those standards," said Stratton, who added that without those fuel checks, water and contaminants can cause serious damage to an aircraft engine.

Stratton once again brought his SN adapter idea to his new flight at Eglin in 2024 and was quickly connected with the 96th Test Wing and AFWERX's innovation incubator.

"Seeing the SN adapter in action really opened our eyes to how we can find, even in the smallest areas, ways to reduce our lengthy processes," said Senior Master Sgt. Thomas Montgomery, POL superintendent. "These adjustments to our daily battle rhythm makes for a more agile and capable Airman that can execute operations downrange."

Eglin's innovation office pushed Stratton's idea forward to the base's iSpark Cell, who approved it late last month, and larger Air Force innovation projects. Those projects, like the Aether Sprint and AFWERX refinery, helped him scale up the SN adapter pitch to reach higher-level Air Force to possibly grant enough funding to provide adapters to all base POL units.

Generally, Airmen entering the Air Force's innovation competitions have an idea and need funding to develop, create a prototype and test their idea. Stratton said he believes he has an advantage on the competition because, in his case, he basically reverse-engineered the innovation process. His SN adapter idea is already created, tested and approved for Air Force use. Stratton just needs funding to be able to provide it to his fellow POL Airmen.

The technical sergeant said he knew he would never financially benefit from his idea and that was never his intention. His goal from the beginning was improving the tedious and sometimes dangerous fuel sampling process. Approximately four in 10 times a fuel sample is taken, jet fuel leaks or sprays on the individual taking the sample.

"I know the adapter works. It's easier and safer to use and saves time," said Stratton, a POL Airman for 10 years with three deployments. "Now that the product exists, we just have to get it into the hands of those POL Airmen, who will benefit from it."

This article was written by Samuel King Jr., Chief of Command Information, Team Eglin Public Affairs, for the Air Force Research Laboratory (AFRL), it has been edited. **For more information, visit www.afrl.af.mil.**

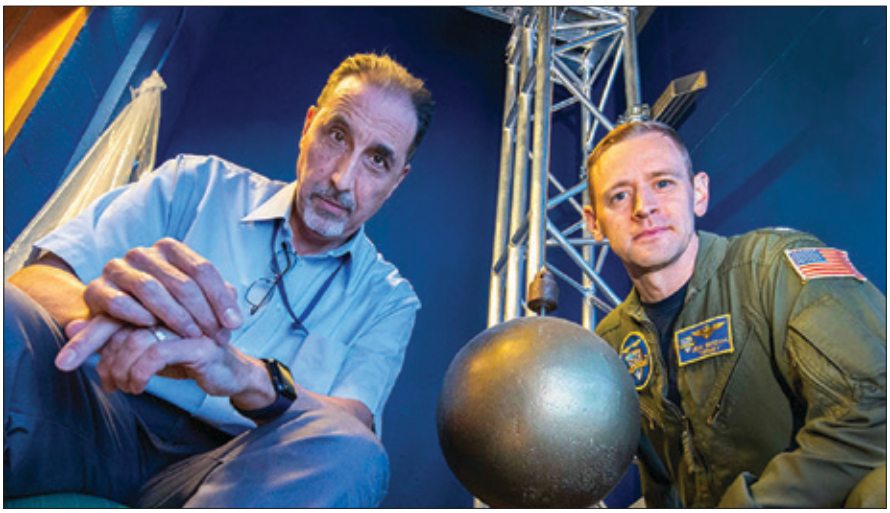
Atomic Fountain for Research in Quantum Sensing Nears Completion of First Phase

Naval Postgraduate School (NPS) physicists are on track to bring the institution's new atomic fountain online – the largest of its kind in the world – for applications to quantum sensing experiments in precise navigation and timekeeping.

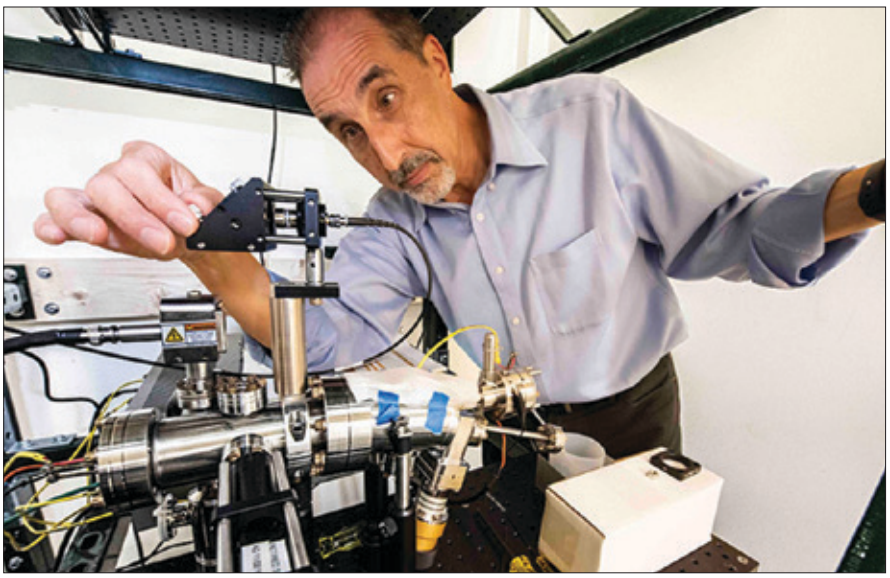
Naval Postgraduate School, Monterey, CA

Using a Defense University Research Instrumentation Program (DURIP) award bestowed last year and plenty of elbow grease, Dr. Frank Narducci, Chair of the NPS Department of Physics, and his Ph.D. student U.S. Navy Cmdr. Jens Berdahl, a former Navy pilot currently pursuing his doctorate through the service's Permanent Military Professor program, are nearing completion of the first phase of construction in what will be a superlatively precise atomic-based instrument.

The device will open the door to a host of defense applications of quan-



Dr. Frank Narducci, professor and Chair of the NPS Department of Physics, and doctoral student U.S. Navy Cmdr. Jens Berdahl are making progress on the installation of an atomic fountain in NPS' Spanagel Hall. Built in an unused elevator shaft, the extremely precise interferometer will help NPS student and faculty researchers advance experimentation in precise navigation and timekeeping. (U.S. Navy photo by Javier Chagoya)



Dr. Frank Narducci, professor and chair of the NPS Department of Physics, is leading the installation of an atomic fountain in NPS' Spanagel Hall. The extremely precise atomic instrument, slated to be one of the largest of its kind when complete in 2025, will provide NPS students, faculty and research partners with a host of defense applications and capabilities in quantum sensing. (U.S. Navy photo by Javier Chagoya)

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tum sensing based on atom interferometry research in general and gyroscope, gravimeter, accelerometer and clock research specifically. This has the potential to provide alternative navigation means in GPS-denied environments as well as detect threats adversaries want to keep hidden.

"The work being conducted by Professor Narducci is an excellent example of the benefits of basic research in support of national defense," said Dr. Kevin Smith, NPS Vice Provost for Research and Innovation. "This research is advancing our state of knowledge about quantum sensing in general but is also being pursued in the context of advanced sensors and the development of precision navigation and timing instrumentation, which is critical for future systems employment in contested environments."

This combination of cutting-edge technology and research coupled with a defense focus is what defines the unique educational experience at NPS for its master's and Ph.D. students, delivering a competitive advantage as called for in the Naval Education Strategy in technical disciplines directly relevant to modern naval warfighting.

Quantum science is one of 14 Critical Defense Technology Areas identified by the Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E), which also funds the DURIP program. The Office of Naval Research (ONR) oversees the Navy's portion of DURIP grants and competitively awards proposals to universities conducting high-quality, relevant research addressing naval-unique needs.

An atomic fountain is essentially an interferometer – a device that extracts information from determining interference – that tosses atoms up and down, not unlike a water fountain. By measuring minute fluctuations in gravity, for example, the device can reveal a treasure trove of information.

Lobbing cold atoms up in an ultra-high vacuum system and measuring how long they take to come down using wave properties of atoms give quantum sensors their extreme precision. To launch the atoms, two finely-tuned lasers are directed at the atoms, one closer and one further from resonance (the frequency the atom "likes" to absorb).

Narducci explained that pushing the atoms with a single laser, the atoms will overheat. The design instead uses two low power lasers that vary in frequency that has the effect of gently tossing the atoms up.

For their initial experiments, Narducci and Berdahl, along with other

members of the growing research team, will use the atomic fountain to measure the period of a Foucault's Pendulum swinging in Spanagel Hall.

Doing so, however, is not so easy as watching it with a stopwatch in hand, Narducci noted.

"If I tell you to measure the swing of the pendulum, but you're not allowed to look at it, how would you do it?" he asked. "One way to do it is the swinging of the pendulum changes the force of gravity on you; a very, very, very, very small amount, but it does change and the atomic fountain can measure that."

Finding a location for the tower involved a clever application of re-employing a former elevator shaft in Spanagel Hall, the tallest building on the NPS campus.

Narducci and Berdahl are constructing the fountain there in two phases. The initial version, which Narducci terms a "baby fountain," will measure nearly 12 feet (4 meters) in height; the final version will stand approximately 100 feet (30 meters) tall.

While a taller fountain does imply greater sensitivity in general, bigger does not necessarily mean better when measuring a relatively small object like the pendulum: as the atoms get further and further away, the gravitational effect of the pendulum gets smaller and smaller. On the other hand, the baby fountain might not be tall enough to provide the best measurement. Having the range of a tall fountain affords maximum flexibility in determining the optimal configuration for experiments.

Furthermore, Narducci observed, taking measurements with a tall fountain is hardly field expedient.

"If we're talking about taking this technology out into the field, we don't have the luxury of taking a tall instrument out and putting it in the ground and letting it record for 24 hours, then moving it two feet to record another 24 hours," he said. "We would like to do this on operationally-relevant timescales."

This is precisely what Berdahl is conducting his Ph.D. work on.

"My dissertation is studying the atomic fountain and showing its precision over operationally-relevant timescales. We're trying to rapidly capture any changes to the gravitational acceleration vector," he explained. "The time period that we're hoping to resolve is the time that it takes for the pendulum to swing once. Overall, we are characterizing the possible precision we can achieve while constraining our system in allowed dwell times. That's a challenge!"

Designed as a "user facility" with both on-site and virtual access planned, the atomic fountain will be completely automated and configurable via a web-based interface to connect with the Naval Research and Development Establishment (NR&DE) and other partners involved.

Ultimately, the atomic tower will be in the hands of NPS' students and defense-expert faculty in 2025 who will be learning and working on it, offering unparalleled education and research opportunities.

Berdahl is immeasurably excited at the prospect of imparting this knowledge.

"Having a grounding in quantum mechanics and how we might use these technologies in the field – its capabilities and constraints – is everything for the leaders who are coming through NPS and moving on to different acquisition jobs, engineering or duty officers," he said. "They have to understand what this environment in the future might look like, and that includes all the technologies that might be available."

"That conversation is very, very different if you have quantum sensors than if you don't," Berdahl added.

This article was written by Matthew Schehl, Senior Writer and Editor for the Naval Postgraduate School. **For more information, visit www.nps.edu.**

Revolutionizing the Waves: A Breakthrough in Surf Observation Technology for Sailors and Marines

A team of Army and Navy scientists and engineers have developed a real-time sensing technology for deciding whether conditions are suitable for landing troops on enemy shores.

Office of Naval Research, Arlington, VA

Imagine being entrusted with the vital responsibility of deciding whether conditions are suitable for landing troops on enemy shores, using nothing more than a ruler and tennis ball.

It sounds like a scene from a film, yet this is the reality for warfighters who rely on such basic tools to authorize troop movements from vessel to shore — employing eyesight observations to estimate wave height, a ruler to measure water depth and sometimes a tennis ball to determine current wave speed.

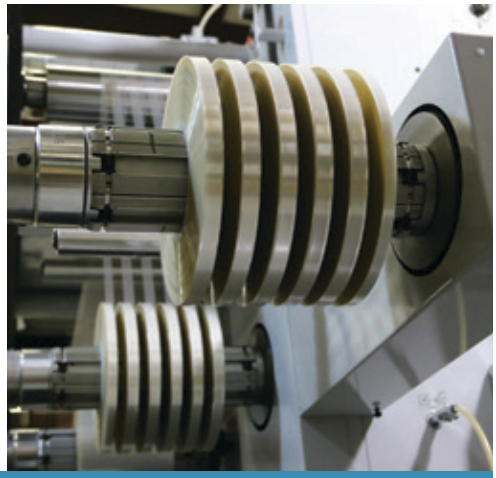
To improve this antiquated, time-consuming process, the Office of Naval Research (ONR) Global TechSolutions program — which sponsors the development of rapid prototype solutions based on direct requests from Sailors and Marines — worked with scientists and engineers from the Naval Research Laboratory (NRL) and the U.S. Army's Engineering Research and Development Center (ERDC) to create the latest advancement in surf observation (SUROB) technology.

SUROB was among many innovations recently demonstrated at the Technical Concept Experiment (TCE) 24.2 held at Marine Corps Base Camp Pendleton, California.

Under the sponsorship of Dr. Joong Kim, a program officer in ONR's Ocean Battlespace Sensing Department, and in collaboration with I Marine Expeditionary Force (MEF), the event showcased ONR-sponsored technologies to enhance Marine Corps capabilities in amphibious operations — including explosive hazard defeat/mine countermeasures as well as intelligence, surveillance and reconnaissance.

"This hands-on testing not only facilitates crucial feedback, but also fosters the integration of innovative solutions into operational environments, ultimately advancing the effectiveness of the Marine Corps mission," said Kim.

An essential part of the TechSolutions SUROB solution is the NRL-developed Lit-



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U.S. Marines test the latest advancement in surf observation (SUROB) technology. SUROB was among many innovations recently demonstrated at the Technical Concept Experiment (TCE) 24.2 held at Marine Corps Base Camp Pendleton, California. (Image: U.S. Navy)

toralLens system and the ERDC-developed Littoral Imaging Software (LIS) for real time sensing of the environment. LittoralLens is a compact, easy-to-use stereoscopic camera system for shore and LIS is an unmanned aerial system, and both enable Marines to automatically measure water flow and wave patterns along coastlines.

"Now a warfighter can set up a stereoscopic camera on a tripod and let it collect measurements for as long as they need — or launch a small drone that can hover over the beach and take imagery," said Jason Payne, TechSolutions director.

Equally as important is the fusion of this data for display on an Android Team Awareness Kit (ATAK) tablet, which is standard issue for Marines, ensuring that this new technological advancement would be compatible from the start.

"This sensor information is combined with existing environmental forecasts based on historic satellite images of the shoreline to calculate a Modified Surf Index score, which determines whether amphibious movement is safe or not. This score is then displayed on the ATAK tablet," said Payne. "Ultimately, creating a more accurate, more precise and more repeatable measurement for Marines."

Lt. Col. Joseph Murphy, head of the Ground Combat Element branch at the Marine Corps Warfighting Lab (MCWL) and guiding the project for MCWL, stressed how successful the project has been and how TechSolutions can benefit the operational force.

"We recognize that a problem set like improving surf observation really fits the TechSolutions mold well," said Murphy. "This new SUROB technology adds efficiency to the current processes for beach reconnaissance or modified surf index reporting, which is then utilized by maneuver units and commanders to decide where they want to conduct amphibious operations as well as risk assessment."

Chief Warrant Officer 3 Joseph Lester, Meteorology and Oceanography (METOC) platoon commander for 1st Intelligence Battalion, was among the warfighters to test the tool.

"The METOC Marines at 1st Intelligence Battalion were very grateful to participate in the development of the LittoralLens, and refinement and tailoring of the Littoral Imaging Software. It was rewarding to see how much warfighter input was realized and implemented in a relatively short amount of time," said Lester.

"The hope is that this technology is adopted and fully funded as a program of record so that it can be used to support amphibious operations," Lester added.

This article was written by Cherish T. Gilmore, a contractor for the Office of Naval Research. **For more information, visit onr.navy.mil.**

Application Briefs

Autonomous Undersea Vehicle Completes 100-Hour Demonstration

Anduril Industries
Orange County, CA
Contact@anduril.com
www.anduril.com

Anduril Industries is trying to define the next frontier of autonomous maritime operations. Just as the Dive-LD set a new global standard for Large-Diameter Autonomous Undersea Vehicles (LD-AUV), the Dive-XL, Anduril's commercial Extra-Large Autonomous Undersea Vehicle (XL-AUV), is setting a new global standard for what is possible for vehicles of this size.

Dive-XLs are at-sea nearly every single day in Australia and the United States, and the vehicle recently concluded a 100 hour single voyage — the longest underway for a vehicle of this class. This, however, is just a waypoint, which will eventually be superseded, as the company moves toward a far more ambitious goal: a 1,000 nautical mile, fully submerged mission that the Dive-XL will conduct in the first half of 2025. That achievement will itself be just another important milestone as the company seeks to unlock the full, multi-thousand mile range of the vehicle.

Unlike hybrid uncrewed submarines, which require frequent contact with the surface, Dive-XL is designed to operate undersea for the entirety of its missions. This is not just a technical achievement — it is a mission-critical capability. The longer an XL-AUV can stay submerged, the more operational flexibility it provides its commanders.

Dive-XL's producibility stems from a fundamentally different approach to design and manufacturing. It's modular design is freely flooded, relying on smaller, commercial off the shelf pressure vessels to house critical systems like navigation, communications, and batteries. The core vehicle is constructed from affordable and commercially available marine grade materials such as aluminum and fiberglass. This architecture reduces complexity, lowers costs, and makes Dive-XL highly manufacturable with resilient supply chains across the globe. Production doesn't require bespoke materials and specialized shipyard labor, but can instead tap into the commercial automotive workforce, minimizing retraining time and expanding the industrial base.

Across two completely different maritime environments on opposite sides of the Pacific Ocean, Dive-XL vehicles are in and under the water right now, undergoing daily testing to validate their endurance, reliability, and versatility. Following the completion of the Ghost Shark R&D program last year, the platform is slated to enter production, with the stated intent of the Australian Government to have first production vehicles in the water by the end of 2025. These production variants will feature substantial improvements in range, speed, navigation and affordability, all while being easier to manufacture at scale.

www.anduril.com

Updated High-Pressure Turbine Kit for A320neo Engine

CFM International
Cincinnati, OH
513-552-3272
www.cfmaeroengines.com

In December, the Federal Aviation Administration (FAA) and the European Union Aviation Safety Agency (EASA) certified the updated high-pressure turbine (HPT) hardware durability kit for the CFM LEAP-1A engines that power Airbus A320neo family aircraft. The durability kit was designed to increase time on wing, especially in hot and harsh environments, and includes the HPT stage 1 blade, HPT stage 1 nozzle, and forward inner nozzle support.

"This new hardware is fulfilling our promise to ensure that LEAP-1A engines achieve the same level of maturity, durability, and time on wing that our customers have enjoyed with the CFM56 product line," said Gaël Méheust, President and CEO at CFM International.

To ensure that the improvements would address durability challenges in harsh environments, CFM worked with a team of geologists to engineer dust that mimicked what engines experience in these environments around the world. Using a proprietary dust ingestion system, the company was able to replicate HPT blade wear that operators were seeing in the field. The dust ingestion system allowed CFM to design, test, and validate improvements to increase the durability and time on wing of these parts.

There are currently more than 3,500 LEAP-powered aircraft in service, and the engine has surpassed 60 million flight hours after making its debut eight years ago. The engine has a 35,000-pound thrust capability, and is featured on the first Airbus A321XLR that recently entered commercial service with Iberia.

www.cfmaeroengines.com

Quantum Processor Unit Manufacturing

STMicroelectronics
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STMicroelectronics has signed a new collaboration agreement with French quantum computing startup Quobly to produce quantum processor units (QPUs) at scale. By leveraging STMicroelectronics' advanced FD-SOI semiconductor process technologies, this collaboration is set to make large-scale quantum computing feasible and cost-effective, positioning both companies at the forefront of next-generation computing technologies.

Quobly aims to break the 1-million-qubit barrier by 2031, targeting applications ranging from pharmaceuticals, finance, materials science and complex systems modeling, including climate and fluid dynamics simulations. Together, the two companies aim to achieve a breakthrough in quantum computing by utilizing their common expertise in FD-SOI, driving down research and development costs, and addressing the market's demand for scalable, affordable quantum computing processors.

"This collaboration is unparalleled in the quantum computing landscape. Working closely with STMicroelectronics will fast-track the industrialization of our quantum processor technology by several years. We are thrilled to leverage ST's semiconductor manufacturing expertise, which will speed up the development of a fully fault-tolerant quantum computer," said Maud Vinet, CEO of Quobly.

In the first phase of the collaboration, Quobly and ST will adapt ST's 28nm FD-SOI process to match Quobly's requirements, targeting a 100 Qubit Quantum Machine with proof of scalability beyond 100k physical qubits. ST will leverage its integrated device manufacturer model to bring Quobly its ability to bridge co-design, prototyping, industrialization and volume production at scale in 300mm fabs using FD-SOI, a technology it has developed and exploited commercially for years across automotive, industrial and consumer applications.

"This collaboration is building on ST's IDM strengths, centered around our Crolles facility, integrating together our process R&D expertise, our circuit design know-how and volume manufacturing. We truly believe that pairing Quobly's quantum expertise with ST's FD-SOI knowledge and manufacturing will allow us to accelerate economically viable, large-scale quantum computing solutions," said Remi El-Ouazzane, President, Microcontrollers, STMicroelectronics.

www.st.com

Excalibur Flight Test and Modification

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Leonardo, 2Excel and the Ministry of Defence recently announced that the flight test aircraft 'Excalibur' Flight Test Aircraft (FTA) has successfully completed its first phase of modification and flight testing. The milestone saw Excalibur, now equipped with new side and belly pods, assessed for stability during flight. The aircraft will now undergo further engineering work at QinetiQ's Boscombe Down facility in Wiltshire.

Excalibur is a former commercial Boeing 757 aircraft that is being overhauled into a flying laboratory for combat air technology. It is part of the UK's Future Combat Air System (FCAS), which will include the core fighter jet — the next generation 'Tempest' — being developed under the Global Combat Air Programme (GCAP), as well as a broader range of capabilities such as uncrewed aircraft, information systems and weapon systems.

The first phase of modification saw the Excalibur FTA equipped with new side and belly pods, changing the outer mould line of the aircraft. These pods are designed to host the Integrated Sensors, Non-Kinetic Effects (ISANKE) and Integrated Communications Systems (ICS) that Leonardo UK and its international partners are developing as part of their work on GCAP. Further modification to the Excalibur FTA aircraft will include a fighter jet-style nose cone, to host advanced radar-based sensor demonstrators.

The focus of the Excalibur program will soon move to the installation of ISANKE & ICS technology demonstrator systems, underpinning the future development of these sophisticated capabilities. Excalibur is expected to fly with advanced new ISANKE & ICS technology on-board within the next few years, when on-board scientists and engineers will be able to test and refine the systems whilst in flight. This will de-risk and accelerate the domain's development program and in turn support the ambitious timescales of GCAP.

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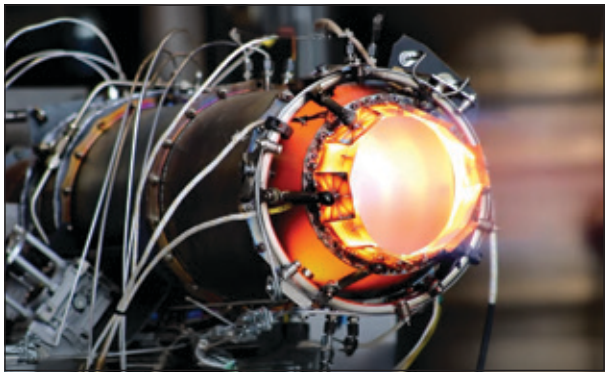

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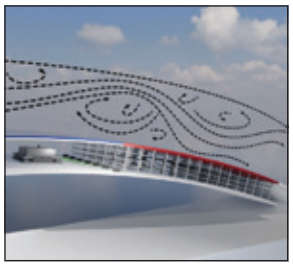

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U.S. NRL and NPS co-developed a tactical decision aid to assist UAV operators with mission planning and situational awareness. Watch this video to learn more.
www.techbriefs.com/tv/potion

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XMC Video Capture Card

EIZO Rugged Solutions (Orlando, FL) has introduced the Condor VC300xX – an XMC form factor Ultra High-Definition (UHD) video capture card for C5ISR (Command, Control, Communications, Computers, Combat Systems, Intelligence, Surveillance, and Reconnaissance) applications. The Condor VC300xX card can accommodate up to eight SDI video inputs, supporting a mix of 12G, 3G, and HD-SDI resolutions. Additionally, it includes two CVBS capture channels with independent audio support. The Condor VC300xX's multiple SDI inputs and support for various video formats enable consolidated video capture from numerous sensors and cameras to support 360-degree situational awareness and tracking. Its high resolution and low latency make it ideal for mission systems, where decisions must be made quickly based on incoming video intelligence.

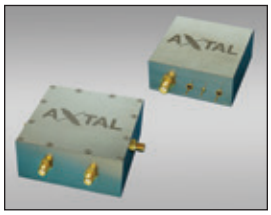
www.eizorugged.com

RF Power Sensors

The new R&S NRPxE power sensors from Rohde & Schwarz (Munich, Germany) offer unmatched performance and versatility. They feature an impressive dynamic range of 80 dB, a video bandwidth of 100 kHz, and the ability to perform up to 1,000 measurements per second. With frequency ranges from 10 MHz to 8 or 18 GHz, the power sensors cater to various measurement needs. Their compact design and ruggedized housing ensure easy handling and reliable operation in demanding environments. The R&S NRPxE sensors feature a user-friendly design with IEEE-compliant label and connector color coding, ensuring safe and secure operation.

www.rohde-schwarz.com

Crystal Oscillators and Modules



Q-Tech Corporation (Cypress, CA) has introduced the new AXTAL GHz Series of high-performance/ultra-low noise/high-frequency crystal oscillators and modules to the U.S. market. Developed and manufactured by Q-Tech's recently acquired European affiliate, AXTAL, these ultra-low phase noise (close-in and noise floor) crystal-controlled sources offer competitive packaging and performance advantages in a range of applications (military, aviation and space). Benefits include higher resolution and accuracy for radar systems, better quality and more transmittable information in communication systems, and higher accuracy and a lower measurement limit in RF measurement systems.

www.q-tech.com

3U VPX SOSA Aligned Plug in Card

Concurrent Technologies (Essex, UK) has introduced the TR MDx/6sd, which is a compute intensive rugged Plug In Card, developed in alignment with the SOSA™ Technical Standard and features a lightweight build and prime performance across thermal range, 40GBASE-KR4 or 100GBASE-KR4 Primary Ethernet Data plane and Support for FIPS 140-3. It features a processor with 10 cores, large memory capacity, local storage, and support for virtualization.

www.concurrent.tech

Microwave Cable Assemblies to 43.5 GHz

Samtec (New Albany, IN) has announced full production quantity availability of its LL043 Series Nitrowave™ high-performance microwave cable assembly. Nitrowave™ is Samtec's new flexible, low-loss microwave coaxial cable product line that demonstrates outstanding amplitude and phase stability in test and measurement, as well as 5G datacom, defense, aerospace and computer/semiconductor applications. Nitrowave™ is easily recognizable by its distinctive orange color and is backed by Samtec Sudden Service® which includes part availability, quick delivery, and access to people and tools that help streamline a design process.

www.samtec.com

XMC GPGPU Card

AMETEK Abaco Systems (Huntsville, AL) has introduced the NVA2102xX, a next-generation XMC GPGPU card powered by the NVIDIA RTX™ A2000 GPU. Engineered for AI processing, real-time video capture, and metadata-rich applications, this rugged card delivers power-efficient performance and cutting-edge capabilities in a compact XMC form factor. Designed for harsh environments and mission-critical applications, the NVA2102xX supports a wide range of advanced features, including: AI-Driven Analytics: Boosts decision-making with 8.25 TFLOPS of FP32 performance. Advanced Video Processing: Supports video format conversion, metadata embedding, and low-latency sensor integration. Rugged Reliability: MIL-STD-810G compliance ensures functionality in extreme conditions. Comprehensive I/O Support: Multiple video input/output options for seamless integration into modern platforms.

www.abaco.com

3U Open VPX Board

Mercury Systems, Inc. (Andover, MA) introduced a new system-on-module (SOM) and 3U SOSA-aligned OpenVPX board powered by Altera's™ most advanced Agilex 9 Direct RF FPGA chips. The DRF2270 SOM and DRF5270 3U board are the latest additions to Mercury's portfolio of Direct RF digital signal processing products that use Altera FPGAs to detect and process information from a wide portion of the electromagnetic spectrum. These commercially available products directly digitize radio frequency signals at the antenna, eliminating the analog signal down conversion stages required by legacy hardware.

www.mrcy.com

V3-1708 Single Board Computer

Curtiss-Wright's Defense Solutions Division (Ashburn, VA) announced that it is collaborating with DDC-I to deliver industry-leading Future Airborne Capability Environment®, FACE® conformant DO-178C/ED-12C Design Assurance Level A (DAL A) processing for use in safety-certifiable multi-core computing avionics applications. Curtiss-Wright's rugged V3-1708 single board computer (SBC) with off-the-shelf AC 20-152A DAL A certification packages, combined with DDC-I's Deos™ configurable multi-core real time operating system (RTOS), enables system designers building avionics systems for aerospace, military, and other high-reliability markets to rapidly deploy rugged safety-certifiable solutions.

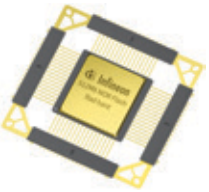
www.curtisswrightds.com

Test Cable Assemblies

Pasternack (Irvine, CA) has announced the launch of their new 1.0mm test cable assemblies. These cables are engineered to deliver exceptional performance in high-frequency environments up to 110 GHz, addressing the critical needs of industries such as telecommunications, aerospace, and defense, where precision and durability are paramount. The new line is designed for rigorous testing applications, offering unparalleled signal clarity and robust performance even in the most challenging conditions. Each 1.0mm test cable features a rugged armored coaxial design that withstands temperatures from -55 °C to 125 °C, ensuring resilience in extreme testing environments. With ultra-low insertion loss and stable phase performance, these cables minimize signal interference, making them ideal for applications where maintaining signal integrity is essential.

www.pasternack.com

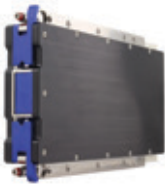
Flash Memory for Space Applications



Infineon Technologies AG (Munich, Germany) announced the industry's first radiation-hardened-by-design 512 Mbit QSPI NOR Flash memory for space and extreme environment applications. The new device offers a fast quad serial peripheral interface (133 MHz) and the highest density, radiation, and single-event effects (SEE) performance available in a fully QML-qualified non-volatile memory for use with space-grade FPGAs and microprocessors. The new device, which was funded in part by the U.S. Air Force Research Laboratory (AFRL) and jointly developed with Microelectronics Research Development Corporation (Micro-RDC), is based on Infineon's field-proven SONOS (Silicon-Oxide Nitride-Oxide-Silicon) charge gate trap technology and operates at speeds up to 30 percent faster than lower density alternatives.

www.infineon.com

V6067 3U VPX SoC FPGA



New Wave Design (Eden Prairie, MN) announce the release of its latest innovation, the SOSA-aligned V6067 3U VPX Versal® Premium Adaptive SoC FPGA + Ethernet Offload I/O Module with QMC Sites. This state-of-the-art module is designed to deliver unparalleled performance and versatility for demanding applications in defense, aerospace, telecommunications, and industrial automation. The V6067 leverages the powerful AMD Versal® Premium Adaptive SoC (System-on-Chip, ASoC) FPGA, and the NVIDIA® ConnectX®-7 Ethernet Offload ASIC, allowing the system designer the off-the-shelf world-class Ethernet performance of the ConnectX®-7 while deploying unique data processing and security algorithms in the onboard ASoC device therefore providing a highly configurable platform that combines the benefits of an adaptable hardware architecture with the performance of a multi-core processor.

www.newwavedesign.com

Multi-Protocol Bus Interface Card

Shift5 (Arlington, VA) announced its new multi-protocol Bus Interface Card (BIC). This cutting-edge hardware offers unmatched capabilities for simultaneously interfacing with multiple disparate serial bus protocols used onboard modern and legacy transportation and defense platforms. It can begin capturing data within 50ms of applying power to a platform and, using Shift5 software, detect and capture malformed data messages — an industry first — helping improve fleet security, availability, and resilience. The Shift5 BIC can seamlessly interface with six of the most common serial protocols, including ARINC-429, ASCB, CAN, MIL-STD-1553B, RS-422, and RS-485. Development is underway to add support for proprietary, specialized, and custom protocols.

www.shift5.io

PCIe/NVMe Flash Drives

Smart Modular Technologies (Newark, CA) announced its new ruggedized T6EN PCIe/NVMe flash drives for aerospace, defense, and industrial applications. This new family of SSDs is available in U.2, E1.S and M.2 2280 form factors, enabling flexibility for end users based on their specific application and configuration needs. These T6EN SSDs offer capacities up to 15TB (terabytes) for the U.2 version and up to 8TB for the E1.S and M.2 2280 versions. All three versions utilize 3D TLC flash memory. All versions of the T6EN SSDs feature AES-XTS 256-bit encryption that automatically protects data written to the drive. They are also OPAL 2.0 compliant, providing an industry-standard security protocol to protect data on the SSDs from being accessed by unauthorized users.

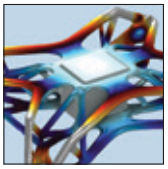
www.smartm.com

Single-Slot PXIe Controller

Pickering Interfaces (Clacton-on-Sea, UK) announced its next-generation single-slot PXIe embedded controller (model 43-920-002) – the most compact and powerful 3U one-slot embedded controller available for the PXI Express platform. Debuting at electronica, the world's leading trade fair for the electronics industry, the new module builds on Pickering's existing controller offering. Pickering's model 43-920-001, its first PXI embedded controller, was the first single-slot Gen 4 controller available for PXI Express platform. As well as giving customers a unique and powerful new option for their controller choice, it enabled Pickering to provide 'one-stop shop' turnkey PXIe systems consisting of chassis, embedded controller switching/simulation/instrumentation modules, and cabling all under one PO, making purchasing and test system integration much more straightforward.

www.pickeringtest.com

Product Spotlight



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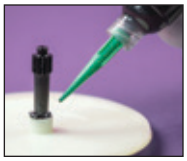

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Highland Technology, Inc.	20	highlandtechnology.com
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Master Bond Inc.	34, 39	masterbond.com
maxon	27	maxongroup.us
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New England Wire Technologies	13	newenglandwire.com
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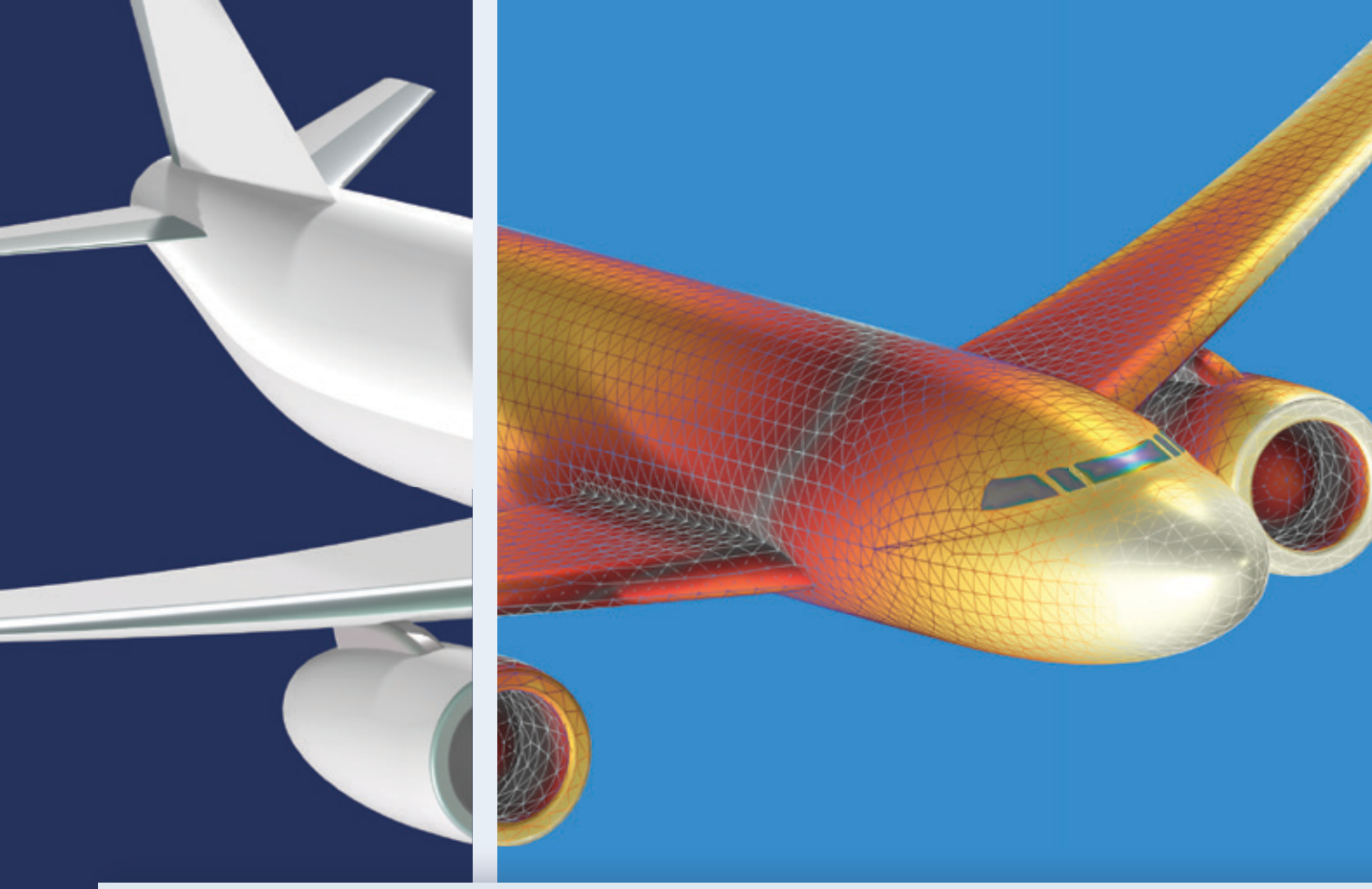

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